

REMARKS

Claims 1-10 are pending. Claim 11 has been canceled without prejudice.

Issues Under 35 U.S.C. 103(a)

The following rejections are pending:

- (A) Claims 1 and 5-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cheung et al., US 7,005,541 (US '541) in view of Miura et al., EP 687,662 (EP '662); and
- (B) Claims 1-10 are rejected under 35 U.S.C. 103(a) as being obvious over US '541 in view of EP '662 and further in view of Key et al., US 6,472,558 (US '558).

Applicants respectfully traverse both Rejection (A) and Rejection (B).

Applicants have carefully reviewed the teachings of US '541, EP '662 and US '558 and the Examiner's comments in the outstanding Office Action and respectfully disagree with the Examiner that the presently claimed method is obvious. The present method for producing acetic acid, as described in independent claim 1, has the following features:

- continuously reacting methanol with carbon monoxide in the presence of a rhodium catalyst, an iodide salt, methyl iodide, methyl acetate, and water; and
 - ♦ wherein the carbon monoxide partial pressure in a gaseous phase of a reactor of 1.05 MPa or more,
 - ♦ wherein the methyl acetate content of the reaction mixture of 2 percent by weight or more, and
 - ♦ wherein the acetaldehyde content in the reaction mixture is kept to 500 ppm or less.

The present method is further defined as producing:

- acetaldehyde at a production rate which is 1/1500 or less of the production rate of acetic acid, and
- acetic acid at a production rate of 11 mol/L·hr or more.

As noted in the examples in the present specification, these features give the inventive method improvements over the prior art methods. Furthermore, it is clear from the cited art that these improvements would not be expected.

For instance, Table 2 of page 46 of the present specification shows the advantages of the of the present invention and is reproduced below for the Examiner's convenience.

Table 2¹

		Example			Comparative Example	
		1	2	3	1	2
Reaction condition	Temperature (°C)	188	186	188	187	188
	Pressure (MPaG)	3.0	2.7	3.5	2.8	2.8
	CO partial pressure (MPaA)	1.3	1.2	1.8	0.97	1.0
	H ₂ partial pressure (kPaA)	30	31	30	140	175
	Water content (% by weight)	1.2	1.8	1.7	8.0	4.0
	MeI content (% by weight)	14.3	12.1	14	13.0	14.5
	Rh content (ppm by weight)	800	650	800	650	660
	LiI content (% by weight)	9.6	9.9	10.9	5.0	22.9
	MA content (% by weight)	5.5	5.5	5.3	1.6	1.3
	AD content a (ppm by weight)	1050	820	710	800	980
	AD content b (ppm by weight)	400	400	400	300	-
Reaction result	Acetic acid STY (mol/L·hr)	19.4	11.6	23.5	11.7	25.2
	AD-STY (mmol/L·hr)	4.3	3.2	2.3	10	35
	AC/AD ratio (ratio in production rate)	4500	3600	10000	1200	600
	CO ₂ -STY (mmol/L·hr)	18	13	18	120	20
	CH ₄ -STY (mmol/L·hr)	20	8	16	11	-
Crude acetic acid a	PA content (ppm by weight)	180	120	115	600	1800
	Cd content (ppm by weight)	1.6	0.5	1.4	3.0	4.9
	Chameleon value (min)	40	160	80	30	-
	Hexl (ppb weight)	-	-	-	100	720
Crude acetic acid b	AD removal percentage (% by mol)	50	30	25	66	-
	PA content (ppm by weight)	75	75	65	350	-
	Cd content (ppm by weight)	0.2	0.2	0.3	1.0	-
	Chameleon value (min)	190	190	190	140	-
	Hexl (ppb by weight) *1	-	28	-	30	-
	Hexl (ppb by weight) *2	<50	<50	<50	-	-

Hexl (ppb by weight)*1: Data analyzed by ECD-GC

Hexl (ppb by weight)*2: Data analyzed by GC-MS

¹ "CO₂-STY" indicates the production rate of carbon dioxide in mmol/L·hr; "CH₄-STY" indicates the production rate of methane in mmol/L·hr; "AD content a" represents the acetaldehyde content of the reaction mixture when the low-boiling components 10 were recycled to the reactor 3 without removing acetaldehyde therefrom; "AD content b" represents the acetaldehyde content of the reaction mixture when a predetermined amount of acetaldehyde was removed from the low-boiling components 10 and the remainder was recycled to the reactor 3.

According to Examples 1 to 3, when the carbon monoxide partial pressure in a gaseous phase of a reactor is kept to a value of 1.05 MPa or more, the acetic acid/acetaldehyde ratio at least triples compared to when the carbon monoxide partial pressure is kept to less than this range.

Table 2 also gives the results of varying whether the low boiling components were recycled. The rows labeled "Crude acetic acid a" give the results when the low-boiling components were recycled to the reactor without removing acetaldehyde therefrom. Also, the rows labeled "Crude acetic acid b" give the results when a predetermined amount of acetaldehyde was removed from the low-boiling components and the remainder was recycled to the reactor.

When the low-boiling component is recycled to the reactor without removing acetaldehyde therefrom as shown in "Crude acetic acid a" in Table 2, Examples 1 to 3 show that the inventive conditions are such that a very small ratio of the production rate of acetaldehyde to that of acetic acid of 1/1500 or less can still be achieved and the amount of side products of propionic acid (PA) and crotonaldehyde (CrD) can be kept low.

The rows labeled "Crude acetic acid b" give the results when a predetermined amount of acetaldehyde was removed from the low-boiling components and the remainder was recycled to the reactor. In Examples 1 to 3, 25 to 50 percent by mole of acetaldehyde is removed from the low-boiling components, and the remainder is recycled to the reactor to keep the acetaldehyde content of the reaction mixture to 500 ppm or less. The resulting propionic acid (PA) content and the crotonaldehyde (CrD) content in the "Crude acetic acid b" are very low, the formation of byproducts derived from these compounds are inhibited, and the residence time in the potassium permanganate test (chameleon value) is high. In contrast, in Comparative Example 1, the ratio of the production rate of acetaldehyde to that of acetic acid is as great as 1/1200, and the "crude acetic acid b" has a high propionic acid content, a high crotonaldehyde content, and a low chameleon value, although the acetaldehyde removal percentage is 66 percent by mole, which is much higher than those of Examples 1 to 3.

These advantageous features give the inventive method improvements over the prior art methods. Furthermore, it is clear from the cited art that these improvements would not be expected.

Applicants now turn to the teachings of the cited prior art.

Both EP'662 and US'541 disclose a process for producing acetic acid which utilizes similar catalyst systems containing a Rh catalyst as a main component. Furthermore, they suggest that the existence of acetaldehyde causes the generation of many kinds of undesirable by-products. However, EP'662 does not make any specific proposal on inhibiting the generation of acetaldehyde itself, despite teaching that the acetaldehyde content is maintained to 400 ppm or less by eliminating acetaldehyde.

On the other hand, US'541 achieves an efficient production of acetic acid by keeping the water content low and using a large amount of catalyst, thereby accelerating the production rate of acetic acid. US'541 briefly mentions a method for eliminating acetaldehyde. However, US'541 is completely silent about the appropriate acetaldehyde content and US'541 is completely silent about inhibiting the generation of acetaldehyde itself.

As stated above, claims 1 and 5-10 of the present invention define a method which produces acetic acid sufficiently at a production rate of 11 mol/L hr or more while keeping the production rate of acetaldehyde to 1/1500 or less of the production rate of acetic acid by inhibiting production of acetaldehyde itself with the adjustment of the carbon monoxide partial pressure and acetaldehyde content of reaction mixture. These achievements could not be made by one skilled in the art looking to both US'541 and EP'662.

Accordingly, significant patentable distinctions exist between the present method and the teachings of US'541 and EP'662.

The Examiner, aware that US'541 and EP'662 fail to teach or fairly suggest the features of inventive claims 2-4, cites US'558 in order to cure these deficiencies. However, Applicants respectfully submit that US'558 does not cure the deficiencies discussed above with respect to the method described in inventive claim 1. As such, the combination of US'541, EP'662 and US'558 do not render the present invention obvious.

US'558 relates to a process for preparing acetic acid which utilizes iridium carbonylation and a polydentate phosphine oxide compound as the catalyst. US'558 teaches that the actual catalyst is the polydentate phosphine oxide compound, thus the iridium carbonylation is used with an aim to inhibit by-products from the description of column 4; lines 37-51, Experiments A and B, and Examples 1-5. Furthermore, US' 558 exemplifies some metals as a promoter (for example Ru), however, said list does not contain Rh.

By contrast, EP'662 is completely silent about utilizing iridium or iridium compounds. Furthermore EP'662 is completely silent about utilizing a polydentate phosphine oxide compound. Therefore, EP'662 discloses a different catalyst from that of US'558, thus both teach completely different technological approaches, though both relate to a process for producing acetic acid. In conclusion, each EP'662 and US'558 teach different processes from one another. Therefore, a person skilled in the art would never think to look to US '558 to modify the process of EP'662.

Furthermore, US'541 uses Rh or Rh/Ir catalyst, with the main catalyst being Rh. In this connection, there is no Example in which only Ir is used in US'541. Moreover, US'541 is completely silent about a polydentate oxide catalyst. Moreover, the important feature of US'541 is inhibiting generation of by-products by utilizing the polydentate phosphine oxide compound in combination with the Ir catalyst.

In contrast, the important feature of US'541 is increasing STY (space time yield or the production rate) of acetic acid by maintaining a low water content of the reaction mixture.

As stated above, EP'662 teaches a different catalyst system than US'541 and as such, must solve a different set of problems from one another. Therefore, one skilled in the art would never

look to US'541 to modify the process of EP'662.

Furthermore, none of EP'662, US'541, or US'558 discloses or suggests the finding of the present invention that the production rate of acetaldehyde can be decreased by controlling the carbon monoxide partial pressure and the methyl acetate content of the reaction mixture.

Therefore, if EP'662, US'541, and US'558 are combined, the combined teachings fall short of the inventive method described in present claim 1 which sufficiently produces high quality acetic acid at a production rate of 11 mol/L hr or more while keeping the production rate of acetaldehyde to 1/1500 or less of the production rate of acetic acid by inhibiting production of acetaldehyde itself, due to adjusting the carbon monoxide partial pressure and acetaldehyde content of reaction mixture.

As such, the present invention is patentable in view of the fact that the combination of EP'662, US'541, and US'558 do not teach or fairly suggest the inventive method as defined in claim 1. Withdrawal of the rejections is respectfully requested.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

Conclusion

In view of the above remarks, it is believed that claims are allowable.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Garth M. Dahlen, Ph.D., Esq., Reg. No. 43,575 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

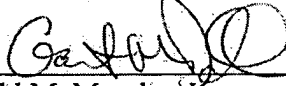
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If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.14; particularly, extension of time fees.

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Respectfully submitted,

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